Hydrol. Earth Syst. Sci. Discuss., 12, C3641–C3648, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C3641/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "The SPARSE model for the prediction of water stress and evapotranspiration components from thermal infra-red data and its evaluation over irrigated and rainfed wheat" *by* G. Boulet et al.

Anonymous Referee #1

Received and published: 13 September 2015

The paper presents and evaluates a land-surface energy flux model (SPARSE) based on the Two-Source Energy Balance (TSEB) modelling scheme. The differences between the original TSEB model and SPARSE (and their justifications) are generally well presented. However, the paper contains gaps in the description of the proposed SPARSE model (i.e. it is not clear how some of the terms were derived) and there is some confusion between the "patch" SPARSE and "parallel" TSEB implementations. Additionally, the comparison of the performance of SPARSE and original TSEB models (and therefore the evaluation of the improvements introduced by SPARSE) needs to

be more robust. For example, there is no discussion of TSEB model in section 3 even though the testing of the first guess assumptions of canopy transpiring at the potential in the TSEB model (as well as in SPARSE) is listed among the main objectives of this paper in the end of section 1. Additionally, in section 4.2 only one statistical parameter (root mean square error) is used in the evaluation, the implementation details and parameterization of the TSEB model are not presented and the discussion is brief and does not always reflect the results presented in figures and tables. Therefore, I would recommend a resolution of a number of issues listed below before the manuscript is reconsidered for publication HESS.

Specific comments:

P7129 L27: Series model is more robust in case of SPARES but not in case of TSEB so this statement should be more precise.

P7130 L2: Should "globally" be "generally"?

P7131 L11-12: Dual source energy balance models allow deriving of both composite and component (vegetation and soil) water stress, not just the latter.

P7131 L15-16: Even though there is currently no operational satellite with dual-view land surface temperature (LST) observations, the soon to be launched Sentinel-3 mission will have such capability (Donlon et al., 2012). This might be worth mentioning.

P7132 L18-19: Provide reference for the study which introduced incremental decrease of transpiration efficiency. Also what does bulk retrieval mean in this context?

P7133 L2-3: It should be made more clear "classical resistance scheme" refers to Penman-Monteith formulation and that this formulation (as well as Priestley-Taylor equation) are used just to obtain the first guess of plant transpiration.

P7134 L1-3: I am not sure how T can be above the potential level since it is initially assumed to be at potential level and later can be reduced if the model doesn't obtain plausible results (i.e. $E < 0$) but is never increased.

P7134 L15-16: The first guess assumptions of the TSEB model are not tested in this study since section 3 deals only with SPARSE model. It would be interesting to evaluate the performance of the original TSEB formulations in retrieving the transpiration and evaporation efficiencies. Possibly it could be done by running SPARSE in prescribed mode, then using the resulting temperature as input to TSEB model and estimating the efficiencies by dividing LE_s and LE_v by their respective potential values.

P7134 L21 – P7135 L2: It would be more clear if the order of the equations presented here corresponded to the order in which those equations are introduced in sections 2.1.1 and 2.1.2 and mentioned on P7144 L5-6 (i.e. latent heat flux equations, followed by energy budget of soil and vegetation and finally relating radiative surface temperature to the temperatures of soil and vegetation).

P7137 L15-16: More details of the iterative procedure should be given. This is its only mention in the whole manuscript.

P7139 L17: How is R_atm obtained in this study? Was it measured (there is no mention of that in section 4.1), estimated from T_a or obtained in another way?

P7140 L4: T_rad is often observed from angles other than nadir and becomes T_rad(theta) where theta is the view zenith angle. How is the view zenith angle accounted for in eq. 17? In appendix A2 there is a vegetation cover fraction (f_c) parameter but there is no explanation of how it is derived and I couldn't see any parameter taking theta into account.

P7141 L5-L9: Why are the stability correction factors not estimated separately if T_0s and T_0v are known? In appendix A1 z_om,s is already estimated and d could also be estimated thus r_a and Richardson number could also be estimated separately for soil and vegetation. What would be the expected effect of estimating r_a,s and r_a,v separately?

P7141 L12: Again, how is f_c estimated.

P7141 L15-18: The "patch" representation of SPARSE model consists of two independent flux networks (one for vegetation and one for soil) which are combined using the fraction of sub-pixel the source of each flux occupies. In this approach the fluxes represent current densities if the resistance networks are considered in electrical terms (Sanchez et al. 2008). In the "parallel" TSEB implementation the interaction between the canopy and soil fluxes is still minimal but the two component fluxes are added up to obtain the total flux. This implies that the fluxes are treated as currents in electronic networks since currents are additive when two parallel branches meet. Therefore, even though both approaches ("patch" and "parallel") are correct based on the assumption they make, they are not directly comparable and the interchangeable use of "patch" and "parallel" terms when describing SPARSE might be confusing when the "parallel" TSEB term is also used in the manuscript. Therefore the difference between the two approaches should be clearly described and taken into account when analysing TSEB and SPARSE model results.

P7147 L28: In the figure the indicated efficiency is 0.6

P7148 – Section 3: What would be the effect of incrementally reducing B_v and rerunning the model in case of negative evaporation instead of setting B_s immediately to 0? You mention this technique as an improvement to original TSEB on P7132 P18-19 so why not implement it in SPARSE. Also, the performance of TSEB should also be assessed in this section (see comment related to P7134 L15-16).

P7149 L3: Was LST acquired from nadir? If it was acquired at a different view zenith angle then how was this taken into account?

P7149 L8: Does residual method mean that residual energy was assigned to LE or H? Also maybe consider the approach from the study of Ingwersen et al. (2015).

P7149 L18-19: In Section 4.2 it is often not clear which models are being discussed. The original TSEB model implementations should be listed here and not only in the caption of Table 1. Why are different references used for the parallel and series ver-

sions of TSEB? Cammalleri et al. (2010) were looking at different representations of wind profile in the canopy but did not present any modifications to the actual TSEB formulations. So is one of the wind profile models presented in Cammalleri et al. (2010) used in the series version of TSEB but not in the parallel? What would be the justification for that and which wind profile model was used? Also implementation and parameterization details of the TSEB model should be clearly stated. For example, what default value of alpha_PT was used, was clumping factor used, was fraction of vegetation that is green (f_g) set to 1 or varied during senescence. In particular it would be interesting to look at the effects of varying or not varying f_g estimate in the TSEB model as it has a large effect on the estimated fluxes and is available in this study since hemispherical photography and destructive sampling were used to estimate LAI.

P7150 L1: If the model is designed to be routinely applied with remote sensing data then it should be explained how the view zenith angle of the LST observations is taken into account.

P7150 L5-6: More thorough statistical analysis should be performed and presented in Table 1 (and Table 2). The effect of bounding LE estimates should be explored by looking not only at RMSE but also other statistical parameters, for example (but not necessarily limited to) bias, correlation or coefficient of variation. During what conditions do the outputs have to be bound? Is it mainly during plant growth stage or senescence?

P7150 L6-13: The description in this paragraph does not reflect the results presented in Table 1. For example, the RMSE of parallel and series versions of SPARSE are not “almost similar” as stated on L7 (see difference between non-bounded models in irrigated wheat), the reduction in RMSE stated on L9 is only true for SPARSE model and the statements on L9-13 are only true for bounded versions of the models. I would suggest rewriting this paragraph (after further statistical measures have been included in Table 1) and being more clear about which version of the model (SPARSE/TSEB, parallel/series, bounded/unbounded) is being discussed.

P7150 L14-15: Are any fluxes recalculated after LE_s and LE_v are bounded? If not, then wouldn’t the estimates for H, G and Rn be the same for bounded and unbounded case?

P7150 L18: Be more clear in what exactly is consistent with Li et al. (2005) and Morillas et al. (2013). What did those studies show?

P7151 L20-23: On L20, should it be “little to no stress” instead of “little to no evaporation”? Furthermore in top-right Figure 3 (low evaporation efficiency) the most accurate retrieval of evapotranspiration efficiency for parallel SPARSE model is for high transpiration efficiencies (small vegetation stress values) which is contradictory with the statement on L22-23.

P7152 L14: How is theta_sat estimated and what is its value?

P7153 L5-9: Can the temporal pattern of agreement be explained by the patch/layer representations present in parallel/series SPARSE model versions being more appropriate at different stages of vegetation development?

P7154 L3-5: Was this finding presented in the results section?

P7154 L5-6: I do not understand this sentence.

P7154 L17: It should be 0.2 not 0.1.

P7154 L27-28: In the rainfed field senescence began around DOY 80 and vegetation was fully brown by around DOY 120 (Fig 3). Looking at Fig 10 the agreement between the soil evaporation efficiencies modelled with SPARSE and soil moisture data agree very well between DOY 120 and DOY 160. Therefore, at least at this site SPARSE models seems to be performing well over “low or senescent vegetation” (although between DOY 80 and DOY 120 the agreement is not so good). This is not fully consistent with statement on L27-28.

P7156 L4-5: How are d and z_om estimated?

Table 1: Add more statistical measures as mentioned in comment P7150 L5-6.

Table 2: Add more statistical measures to be consistent with Table 1. Also, why was the series TSEB model not included in this table?

Table A1: There are some mistakes present in this table. For example r_a, r_as, r_av and r_w have the same definition. Double check the other parameters as well.

Figure 2: This figure is too complicated. I would remove the input data for synthetic test and also the synthetic test branch (broken line) to improve clarity.

Figure 5: The shown plots appear to be for green LAI. It would be good to also show total LAI and possibly f_g, especially if the effect of varying f_g in the TSEB model during senescence is investigated as suggested in comment P7149 L18-19.

Figures 7 and 9: The legend captions should be fixed.

References:

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 7127, 2015.